REMARKS

Claims 5 and 9 are pending in this application. By this Amendment, claim 5 is amended. Support for the amendment to claim 5 may be found, for example, in the specification at page 7, lines 22-23. No new matter is added.

In view of the foregoing amendments and following remarks, reconsideration and allowance of the application are respectfully requested.

I. Rejections Under 35 U.S.C. §103

The Office Action rejects claims 5 and 9 under 35 U.S.C. §103(a) over U.S. Patent No. 3,558,375 to Engeler ("Engeler") in view of U.S. Patent No. 5,714,407 to Maeno et al. ("Maeno"); rejects claims 5 and 9 under 35 U.S.C. §103(a) over U.S. Patent No. 3,772,102 to Tiemann et al. ("Tiemann") in view of Maeno; rejects claims 5 and 9 under 35 U.S.C. §103(a) over U.S. Patent No. 3,960,623 to Gantley ("Gantley") in view of Maeno; and rejects claims 5 and 9 under 35 U.S.C. §103(a) over U.S. Patent No. 4,251,300 to Caldwell ("Caldwell") in view of Maeno. Because these rejections are related, they are addressed simultaneously below. Applicants respectfully traverse the rejections.

By this Amendment, claim 5 recites, *inter alia*, "A method for evaluating crystal defects of a silicon wafer comprising ... observing etch pits, which originated from crystal defects, formed on the etched surface of the wafer, wherein the silicon wafer of which crystal defects are evaluated has low electrical resistivity of 1 Ω•cm or less, and the etching solution is a mixture of hydrofluoric acid, nitric acid, acetic acid and water further including iodine or iodide, the etching solution having a volume ratio of hydrofluoric acid : nitric acid : acetic acid : water of 1 : 13-17 : 4-8 : 4-8 and includes iodine or iodide in a range from 0.01 g to 0.09 g per 1 liter of total liquid volume of the etching solution to decrease the etching rate of the etching solution, and the etching solution is adjusted to have an etching rate of 100 nm/min or less for the silicon wafer." Applicants respectfully assert that none of the applied

references, individually or in combination, would have rendered obvious each and every feature of claim 5.

The Office Action asserts that Engeler, Tiemann, Gantley and Caldwell disclose exposing a wafer to an etching solution, observing etched patterns on the surface of the wafer, wherein the etching solution includes acetic acid, iodine, nitric and HF. See Office Action, pages 4, 6, 8 and 9. However, the Office Action acknowledges that neither Engeler, Tiemann, Gantley nor Caldwell disclose an etching solution that has a ratio of hydrofluoric acid : nitric acid : acetic acid : water from 1 : 13-17 : 4-8 : 4-8 and includes iodine or iodide in a range from 0.01 g to 0.09 g per 1 liter of the total liquid volume of the etching solution, or that the wafer has a low electrical resistivity of 1 Ω•cm or less. See Office Action, pages 5, 6, 8 and 9. Therefore, the Office Action applies the disclosure of Maeno to allegedly address the discrepancies of Engeler, Tiemann, Gantley and Caldwell.

The Office Action asserts that Maeno discloses an etching solution comprising HF, nitric acid, acetic acid and iodine, and that the concentrations of the acids may vary. See, for example, Office Action, page 7. The Office Action further asserts that Fig. 3 of Maeno discloses that the amount of acetic acid in an etching solution decreases the etching rate of the etching solution and, thus, the Office Action asserts that Maeno provides evidence that changing the concentration of the elements of the etching solution appears to be a result-effective variable. Therefore, the Office Action concludes that it would have been obvious for one of ordinary skill in the art to have modified the acid concentrations of the etching solutions disclosed in Engeler, Tiemann, Gantley, Caldwell and Maeno in order to adjust the etching rate to be within the claimed range. Applicants respectfully disagree.

Conventionally, it is problematic to accurately evaluate crystal defects of a silicon wafer with low electrical resistivity, such as 1 Ω•cm or less. See specification, page 3,

line 8 - page 4, line 17. However, the combination of all the features recited in claim 5 allows one to accurately evaluate crystal defects of a silicon wafer with low electrical resistivity. This is achieved by: adding iodine or iodide, which prevents formation of an unsaturated oxide film or a stain film, to an etching solution; increasing a ratio of nitric acid, which is an oxidizing agent that increases an oxidizing rate at defect sites of the silicon wafer in order to enhance the selectivity of etching; and decreasing an etching rate of the etching solution. See specification, page 9, line 25 - page 10, line 10. Therefore, by using the claimed etching solution, one can accurately evaluate crystal defects of a silicon wafer by observing etch pits formed on the etch surface of the wafer, where the etch pits originated from crystal defects. See specification, page 7, lines 22-23. Accordingly, to accurately evaluate crystal defects of a silicon wafer an etching solution with all the features recited in claim 5 must be used.

In contrast, none of the applied references are directed to evaluating crystal defects of a silicon wafer by observing etch pits, which originate from crystal defects, formed on the etched surface of the wafer. Therefore, Applicants respectfully assert that it would not have been obvious to one of ordinary skill in the art to have modified the solutions disclosed in the applied references to be within the claimed ranges, at least because none of the applied references provide any reason or rationale that the etching solution can or should be used to observe crystal defects.

First, Engeler is directed to the fabrication of diodes comprising a step of etching, and is not directed to a method for evaluating crystal defects of a silicon wafer with low electrical resistivity. The Office Action asserts that col. 6, lines 28-32 of Engeler discloses observing etch pits. However, this portion of Engeler merely discloses viewing a desired pattern that is produced by etching while exposing the photoresist film to ultraviolet light. Therefore, Engeler does not disclose that the etch pits are originated from crystal defects, but rather Engeler discloses observing predetermined etched patterns formed by etching and exposure to

ultraviolet light. Applicants respectfully assert that crystal defects of a silicon wafer cannot be evaluated by observing the etched patterns as disclosed in Engeler. Further, at least because Engeler does not recognize that the etching solution can or should be used to evaluate crystal defects of a silicon wafer by observing etch pits, which originated from crystal defects, formed on the etched surface of the wafer, it would not have been obvious to one of ordinary skill in the art to have modified the etching solution disclosed in Engeler to be within the claimed range.

Second, Tiemann is directed to a method for producing a desired pattern of retained and removed portions in a substrate layer of a material selected from the group consisting of silicon nitride, an oxide of silicon, and an oxynitride silicon. See Tiemann, Abstract. The Office Action asserts that Tiemann, at col. 4, lines 19-25, discloses observing etch pits formed on the etched surface of the wafer. However, this portion of Tiemann merely discloses transferring a predetermined pattern from the photoresist material to a substrate layer and then observing the pattern thus formed. See Tiemann, col. 4, lines 13-14. Therefore, Tiemann fails to disclose observing etch pits, which originated from crystal defects, and thus, crystal defects of a silicon wafer cannot be evaluated by observing the etched patterns disclosed in Tiemann. Applicants respectfully assert that at least because Tiemann does not disclose that an etching solution can or should be used to evaluate crystal defects of a silicon wafer by observing etch pits that originated from crystal defects formed on the etched surface of the wafer, it would not have been obvious to one of ordinary skill in the art to have modified the etching solution disclosed in Tiemann to be within the claimed ranges.

Third, Gantley is directed to selectively masking portions of a semiconductor body for an etching operation. The Office Action asserts that Gantley, at col. 4, lines 10-14, discloses observing etched portions of a semiconductor body. However, Gantley merely discloses

applying a membrane to the portion of the wafer surface that is not to be etched, and then the combination of the wafer and the membrane is exposed to an etching solution. See Gantley, col. 1, lines 46-55, col. 2, lines 66-68 and col. 3, lines 44-51. Therefore, Gantley discloses observing the etched portions of the substrate that were not covered by the membrane and, thus, crystal defects of a silicon wafer cannot be evaluated by observing the etched patterns as disclosed in Gantley. Applicants respectfully assert that at least because Gantley does not disclose that an etching solution can or should be used to observe etch pits, which originated from crystal defects, formed on the etched surface of the wafer, it would not have been obvious to one of ordinary skill in the art to have modified the etching solution disclosed in Gantley to be within the claimed ranges.

Fourth, Caldwell is directed to a method of making a shape-buried layer in a semiconductor structure. The Office Action asserts that Caldwell discloses observing etch pits at col. 3, lines 10-13. However, this portion of Caldwell merely discloses the use of a masking layer that is 8000 Å thick and that the masking layer is removed to expose the substrate to an etching solution wherever buried layers are desired in the substrate. See Caldwell, col. 3, lines 3-9. Thus, Caldwell fails to disclose that the etch pits originated from crystal defects. Rather Caldwell observes etched indentations formed in accordance to the absence of a masking layer. Therefore, at least because Caldwell does not disclose that the etching solution can or should be used to evaluate crystal defects of a silicon wafer by observing etch pits, which originated from the crystal defects, formed on the etched surface of the wafer, Applicants respectfully assert that it would not have been obvious to one of ordinary skill in the art to have modified the etching solution disclosed in Caldwell to be within the claimed ranges.

Further, Maeno does not address the above discrepancies of Engeler, Tiemann, Gantley and Caldwell. The Office Action asserts that Maeno Fig. 3 discloses that increasing

the amount of acetic acid in an etching solution would decrease the etching rate of the etching solution and, thus, the Office Action asserts that Maeno provides evidence that changing the concentration of the elements of an etching solution appears to reflect a result-effective variable. However, the etching solution used in Fig. 3 of Maeno contains HF, HIO_3 and acetic acid; it does not include nitric acid. See Maeno, col. 8, lines 21-60. Therefore, Maeno fails to disclose that adjusting the amount of acetic acid in a composition comprising nitric acid would reduce the etching rate of the composition. Further, Fig. 3 of Maeno shows an etching depth rather than an etching time and, thus, the etching rate cannot be determined from Fig. 3 of Maeno. Additionally, Fig. 3 of Maeno is directed to a glass substrate having Al deposited on the substrate, which is different from the silicon wafer recited in claim 5. Therefore, Applicants respectfully assert that Maeno fails to disclose that the amount of acetic acid in the etching solution of claim 5 is a result-effective variable that will result in the lowering of the etching rate at least because Maeno fails to disclose each element of the etching solution of claim 5 and that the solution is used to etch a silicon wafer.

Further, Maeno discloses a method for manufacturing an electric device having a multi-layer film, an ohmic contact layer and a conductor layer. However, Maeno is not directed to a method for evaluating crystal defects of a silicon wafer with low electrical resistivity. Thus, Applicants respectfully assert that Maeno would not have rendered obvious the claimed etching solution at least because Maeno fails to disclose that the etching solution can or should be used to evaluate crystal defects of a silicon wafer by observing etch pits that originated from the crystal defects formed on the etched surface of the wafer.

As argued above, the method of observing defects of a single crystal as recited in claim 5 requires the precise combination of the claimed etching solution — particularly the relatively large amount of nitric acid and the claimed amount of iodine or iodide — and the claimed etching rate. When the claimed etching solution is used in accordance with the

claimed method, selective etching of the wafer's etched surface originates from the sites of crystal defects and, thus, crystal defects of the wafer may be easily and accurately observed on a wafer with low electrical resistivity. For at least the above reasons, none of the applied references, individually or in combination, provide any reason or rationale for one of ordinary skill in the art to have modified the etching solutions disclosed in the applied references in an attempt to observe crystal defects of a silicon wafer with low resistivity. Therefore, it would not have been obvious to one of ordinary skill in the art to have modified the disclosed etching solutions to comprise components within the claimed ratio and having the claimed etching rate at least because there is no reason or rationale provided for one of ordinary skill to have desired or benefited from such a modification.

For at least the reasons stated above, claim 5 would not have been rendered obvious by Engeler, Tiemann, Gantley, Caldwell and Maeno, individually or in any combination. Claim 9 depends from claim 5 and, thus, also would not have been rendered obvious by Engeler, Tiemann, Gantley, Caldwell and Maeno, individually or in combination. Accordingly, reconsideration and withdrawal of the rejection are respectfully requested.

II. Conclusion

In view of the foregoing, it is respectfully submitted that this application is in condition for allowance. Favorable reconsideration and prompt allowance of the application are earnestly solicited.

Should the Examiner believe that anything further would be desirable in order to place this application in even better condition for allowance, the Examiner is invited to contact the undersigned at the telephone number set forth below.

Respectfully submitted,

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